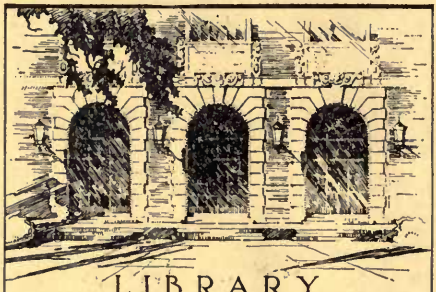

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EXPERIMENTS WITH INSECTICIDES FOR THE SAN JOSE SCALE.

By S. A. Forbes, State Entomologist.

The "California wash" of lime, sulphur, and salt, and the "Oregon wash" of lime, sulphur, and blue vitriol, have been for many years the general reliance of the fruit growers of the Pacific Coast for protection against the San Jose scale. In a letter to me dated October 22, 1901, Prof. C. W. Woodworth, of the Entomological Department of the University of California, said that "the lime, salt, and sulphur mixture is the sole dependence in this state for killing the San Jose scale;" and under the same date Prof. A. B. Cordley, of the Entomological Department of the Oregon Agricultural College and Experiment Station, wrote: "With us the lime, salt, and sulphur compound is a very satisfactory remedy for the San Jose scale, and is used very extensively. In fact, this and the lime, sulphur, and blue vitriol compound are practically

the only ones used for winter sprays for this insect." As early as 1889 the California wash was the only winter remedy recommended for the San Jose scale by the Secretary of the State Board of Horticulture, in the Annual Report of the Board for that year; and in 1896 Prof. John B. Smith, State Entomologist of New Jersey, who visited California for a special study of the San Jose scale and its treatment there, found the lime, salt, and sulphur mixture one of the "favorite insecticides" for that scale in California and on the Pacific Coast generally.*

The introduction of these insecticides in the East has been long delayed, probably owing in large measure to unfavorable reports of experiments made in the Atlantic states. In articles published in Bulletin 3 of the U. S. Division of Entomology, issued in 1896, and in Bulletin 30 of the same series, 1901, p. 34, the reported failure of the California wash in the East is attributed to the frequent occurrence of rains shortly after the insecticide had been applied, and chemical testimony is brought forward in support of this supposition.

USE OF CALIFORNIA AND OREGON WASHES IN ILLINOIS.

In the fall of 1901, when an appropriation of $15,000 for insecticide work on the San Jose scale became available to my office, I was embarrassed by the fact that no effective insecticide previously used by us had been found free from serious liability to injure the more tender fruit trees, or at least their fruiting buds. The peach and the plum were especially liable to serious damage by both the kerosene sprays and the whale-oil-soap solution, the first being injurious to the tree, and the second very commonly destructive to the fruit buds and, of course, to the crop of the following year. At this time I received from Professor Cordley, of Oregon, the above-mentioned letter, in which he suggested that I should give the lime, sulphur, and salt compound a thorough test in Illinois, and further said that in Oregon, where this mixture is thoroughly effective, the climate is as moist during the winter—when the spray is principally used—as in any part of the East. I had additional testimony to the same effect from a former student and assistant of mine, Mr. Fred McElfresh, who informed me, after a year's experience in entomological work at the Oregon Agricultural College, that the weather of western Oregon is very similar to that of the greater part of Illinois.

*Rep. Ent. Dept. N. J. Agr. Exper. Station, 1896, p. 551.

Under these conditions I decided last fall to use the lime, salt, and sulphur mixture, standard in the Pacific states, for all our Illinois insecticide work on the peach and plum, preferring to take the risk of a possible inefficiency of the insecticide rather than the much greater one of serious injury to the orchard tree. The season seemed favorable to the treatment, and highly encouraging reports came in from the field throughout the entire winter up to early March. At this time, in order to secure more precise and comprehensive information as to the value of the Oregon and California washes, I detailed one of my office assistants, Mr. E. S. G. Titus, to carry out a series of experiments with them under various conditions, and sent him to Sumerfield, in St. Clair county, where he remained for three weeks, supervising the treatment of the trees, and making counts of scales and other observations of the results.

Secondary Results of the Experiments.

It was the principal object of these experiments to test the effects of rains on the two washes used, but other important results appeared in the outcome besides those immediately aimed at. Counts of dead and living scales on the check trees not treated and on the experimental trees before treatment, showed a surprising percentage of half-grown scales already dead, the ratio of dead young to living scales varying on different trees and on different parts of the same tree from twenty-one per cent. to sixty-nine per cent. This fact had already been observed in other localities where our insecticide work was in progress, and had, indeed, been noticed and reported as early as 1898 by another assistant of the office, Mr. E. B. Forbes, engaged in distributing to infested trees in southern Illinois the spores of a fungus parasite of the San Jose scale.

This spontaneous death of many of the scales which might have been expected to pass the winter alive, was apparently due in great measure and in both instances to a severe drouth of the preceding year. Consistently with this explanation the dead scales were most abundant on trees worst affected by the drouth, and on parts of trees to which the flow of sap would naturally be least.

Another observation of importance to the investigator was made with reference to the action of the insecticide in loosening the scales of the insects killed by it. In most cases where the application took fatal effect the scales were so far loosened from the bark that they were easily rubbed off, and might be washed away in large numbers by an ordinary rain. As a consequence, if counts were made of dead and living scales upon a tree before treatment, and again after a treatment and after a heavy rain had fallen, the ratio

of living to dead might be as great in the latter case as in the former. It will be seen that by overlooking this circumstance an investigator might easily be led to very erroneous conclusions as to the effects of moisture on the insecticide.

General Features of the Experiments.

The actual effect of rains was experimentally ascertained by heavily spraying the trees with water at selected intervals after treatment with the wash, and by making careful counts of dead and living scales in each case and comparing the ratios so arrived at with those found in the beginning. The trees sprayed with each mixture were treated exactly alike except as to the subsequent application of water, and in this latter respect the different trees received very different treatment. Some, for example, were watered but once, and that the next day after the application of the insecticide wash; and others were watered daily for the seven days next following it. In order to avoid interference with the experiments by rains, which fell three times during the fortnight covered by the greater part of the experiments, some of the trees were covered by canvas tents at night and whenever rain threatened.

General Statement of Results.

Details of all forms and variations of the experiment will be given further on, but it is sufficient for this general statement to say that the general average result of a single spraying of twenty trees with lime, sulphur, and salt was the destruction of 90.6 per cent. of the scales when no water was applied within five days, and of 86 per cent. when water was used. The corresponding result of the application of lime, sulphur, and blue vitriol to fifteen trees was the destruction of 93 per cent. of the scales without water, and 92.2 per cent. when water was applied within the first five days.

Period and Methods of the Experiments.

The experiments on which the above statement rests may be conveniently described in five lots: two with lime, sulphur, and blue vitriol; two with lime sulphur and salt; and one, a special experiment, with both these washes on trees covered by tents. Two of the four experiments above mentioned—one with the California wash and one with the Oregon wash—were begun March 3, and the other two (in which also both washes were used) were begun March 5. The tent experiment was begun on the 21st of the month. Observations on all the lots treated were continued until

March 25; that is, twenty-two days for the first two lots, twenty days for the third and fourth, and five days for the lot under tents. The experiments consisted of a single application of the insecticide in every case, with varying subsequent treatments of the different trees with water. Frequent counts of dead and living scales were made for all of the trees, no attention being paid in these counts to old scales, outworn and dead, but only to those whose size and immature character showed that they belonged to the new generation of the preceding fall. Counts of dead and living scales were made in all cases either before or shortly after the application of the insecticide spray. It was in this way ascertained that an average of about fifty per cent. of the immature scales were already dead on these trees before the insecticide was applied; and that the action of the insecticide was scarcely perceptible within the first twenty-four hours.

Experimental Trees used.

Forty-three trees were used in all the experiments, twenty-five of them apple-trees and eighteen peach. They varied in height from twelve to eighteen feet; in spread of top from eight to twenty feet; and in diameter of trunk from four to nine inches. The average height was fourteen feet, and the average spread, thirteen. The general condition of these trees varied from "very poor" to "excellent," six of them being described as "very poor," eight, as "poor," sixteen, as "fair," ten, as "good," and three, as "excellent." Some of the peach-trees were more than half dead, and many of them in such a condition that the owners were about to remove them. The dry weather of the preceding summer had killed the young growth even on otherwise healthy trees, and in some cases much of the older wood had also died from drouth. All the trees were, of course, infested with the San Jose scale, eighteen of them badly so, and the others to a medium degree.

Weather of the Period.

The weather of the experimental period was the ordinary variable weather of an Illinois March, the temperature at seven o'clock a. m. ranging from 18° F., on the 18th, to 54°, on the 15th, and at noon, from 34°, on the 18th, to 88°, on the 25th. There was an unusual amount of wind from the southeast—on not less than fourteen days out of the twenty-two. Rain fell on six days, and a light snow on one other. The first rain, on March 7, lasted for two and a half hours, but was very light—about two gallons for each experimental tree according to Mr. Titus's estimate. The

temperature at the time was 56°. On the ninth day after the beginning of the first experiment (March 11) the weather was showery, with heavy mist most of the day, the temperature 60° to 64°; and on the thirteenth day (March 15) a heavy shower of rain fell, with hail, for an hour in the afternoon, amounting to ten or twelve gallons to the tree. The 17th and 18th were cold—26° in the morning and 24° at noon on the 17th, and 18° in the morning and 24° at noon on the 18th. The wind blew strong and cold from the northwest, with a light snow on the first of these days. A slow drizzling rain fell on the 20th, beginning at about five in the afternoon and continuing through the night and all the following day.

The insecticide sprays were applied on the 3d, the 5th, and the 20th. March 3 was a partly cloudy day, with a cold raw wind from the east and northeast, the thermometer registering 30° at 7 a. m. and 40° at noon. The 5th was a clear day, with a northwest wind, fairly strong, the thermometer 30° at 7 a. m. and 45° at noon. On the 20th the wind was from the southeast, with a threat of storm which resulted in rain at five o'clock in the afternoon. The temperature was 34° at 7 a. m. and 57° at noon.

Preparation of the Insecticides.

The insecticide washes were prepared in substantially the same manner. For the California wash, fifteen pounds of stone lime were slaked in a little very hot water, fifteen pounds of ground sulphur being slowly poured in during the slaking process with constant stirring of the mixture. This was then boiled for an hour, after which fifteen pounds of salt were added and the boiling continued for fifteen minutes longer. The whole was then poured into a barrel through a strainer, and enough boiling water was added to make fifty gallons. In the preparation of the Oregon wash a pound and a quarter of blue vitriol was used instead of the salt, the crystals of the blue vitriol being dissolved in hot water and the solution added slowly to the slaking lime. The apparatus used was a Morrill and Morley pump, with twenty-five feet of hose and a twelve-foot extension rod with a double Vermorel nozzle.

The Water Sprays to test Effect of Rains.

In wetting down the trees to imitate the effects of rain, fifteen gallons of water were used to a tree, as a rule, a double amount being occasionally applied as a variation of the experiment. For a tree of the average spread of thirteen feet, fifteen gallons of

water was equivalent to a rainfall of a sixth of an inch, amounting to a sharp summer shower. The washing and leaching effect of the application was, however, greater than that of a corresponding shower, since the water spray was not distributed equally over the whole area covered by the tree top, but was made to wet the tree equally in all parts; the middle part of the tree much more freely, consequently, than the outer parts. It would doubtless be fair to say that the fifteen-gallon portion was equivalent in effect on the average experimental tree to a rainfall of a third of an inch, and the double portion, of course, to twice that amount. The time taken for the application of fifteen gallons varied, according to the weather and the size of the tree, from twenty minutes to thirty or thirty-five, and for the thirty-gallon application it was never less than an hour. The water in all cases dripped freely from the trees for some time after spraying ceased, carrying with it so much of the insecticide in solution that the drip was of about the color of the original mixture.

The applications of water were varied systematically as to number, to frequency, and to period of time between the insecticide operation and the first general wetting. Tree No. 1, for example, was wet every day for a week, commencing the next day after the California wash was applied; tree No. 2 was wet but once, and that the day after insecticide treatment; tree No. 3 was sprayed on the 3d with the California wash, and with water on the 6th and every other day thereafter for three days; tree No. 6 was sprayed but once, and then with thirty gallons of water one week after insecticide treatment; and tree No. 9, the same, except that the water was applied at the end of two weeks. Further particulars may be obtained from the detailed accounts of the experiments.

Explanation of Tables.

The four tables in the text have been prepared to present in summary form the detailed results of the treatment for each tree as shown by successive counts of scales on selected sample twigs and branches. Against the number of each tree is placed for each date on which special observations were made, the number of scales counted and the percentage of scales killed by the insecticide up to that time. The first count shows always the percentage of scales found alive at the time of treatment. The last column in each table shows the final effect of treatment in the form of a general average of all the percentages of scales killed, excluding only the first seven days subsequent to the insecticide treatment. At the bottom of each table is a series of data for the entire lot of

trees, corresponding in form to those given in the body of the table for each tree.

Experimental Details.

First Lot of Trees. California Wash

Nine apple-trees sprayed with lime, sulphur, and salt on the 3d day of March. Weather partly cloudy, with cold raw wind from the east-northeast; temperature, 30° at 7 a. m. and 40° at noon.

Dead and living scales were first counted on these trees the following day, March 4. Although the fact was not known at the time, it became apparent later by comparison of percentages of scales on these trees with those found on check trees and on other lots counted before insecticide treatment that no discoverable effect of the insecticide had been produced at the time this first count was made. If any scale insects had been killed so soon, their appearance had not yet sufficiently changed to indicate the fact. The percentages found on this first day are, consequently, to be taken as indicating the ratio, before treatment, of dead and living scales among the young of the preceding year. One thousand three hundred and fifty such scales were counted in all, and 52 per cent. of these were alive, 48 per cent. having died from unknown causes, in most cases probably from drouth.

In determining the effect of the insecticide under the varying conditions supplied, this first count of living scales was made the starting point for the calculation of the percentages of scales killed; that is, if only 50 per cent. of the scales were found alive at the beginning of the experiment, the destruction of scales by the insecticide was figured on this 50 per cent., those dead in the beginning being, of course, ignored. Counts were made upon carefully selected specimen twigs or branches, the number counted each time varying from 100 to 400, and the totals for each tree, from 300 to 1,350. The total number of scales counted from this lot on nine trees was 9,000.

The effect of the insecticide was only gradually made manifest, and was, as a rule, not fully produced until about the tenth day, although the difference between the final result and that apparent at the end of the first week was really but small. Consequently, in describing the different features of the experiment, the average of the counts after the first week will be taken to express the final effect of the insecticide in destroying the San Jose scale.

As these various trees were treated subsequent to the insecticide spray by an application of various amounts of water at different intervals, it will be necessary to discuss each tree separately.

LOT I. SPRAYED WITH LIME, SULPHUR, AND SALT, MARCH 3.

Tree	Scales	Mar. 4	Mar. 6	Mar. 8	Mar. 9	Mar. 10	Mar. 15	Mar. 18	Mar. 20	Mar. 22	Mar. 23	Mar. 25	Mar. 10–15
1	No. counted	150	200	400	....	300	200	....	....	200	350	300	1350
	Per ct. alive	40	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	75	84	....	83	74	....	....	74	78	85	79
2	No. counted	150	100	....	....	....	100	....	....	100	300	100	600
	Per ct. alive	37	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	78	....	....	....	86	....	....	95	87	92	90
3	No. counted	200	150	....	....	150	100	150	...	....	....	100	500
	Per ct. alive	29	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	53	....	....	79	89	88	....	....	....	72	78
5	No. counted	150	....	....	150	....	300	....	150	....	....	100	550
	Per ct. alive	47	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	....	80	....	90	....	91	....	....	94	92
6	No. counted	150	....	....	150	....	150	....	....	....	....	150	300
	Per ct. alive	64	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	....	84	....	86	....	....	....	....	86	86
7	No. counted	150	....	150	....	200	150	....	....	....	....	150	500
	Per ct. alive	68	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	80	....	83	89	....	....	....	....	92	88
8	No. counted	100	100	....	....	....	....	150	....	150	....	150	450
	Per ct. alive	54	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	54	....	....	....	....	90	....	84	....	91	88
9	No. counted	150	....	300	....	....	200	150	300	....	....	150	800
	Per ct. alive	56	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	83	....	....	87	85	89	....	....	94	89
10	No. counted	150	150	....	150	....	200	....	250	....	....	150	600
	Per ct. alive	69	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	77	....	95	....	99	....	95	....	....	92	95
Totals	No. counted	1350	700	850	450	650	1400	450	700	450	650	1350	5650
	Per ct. alive	52	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	67	82	86	82	87	88	92	85	83	88	86

Tree No. 1.—A tree sixteen feet high, with a nine-inch trunk and a twenty-foot top; in fair general condition, but badly infested with the San Jose scale. After insecticide treatment March 3, sprayed with fifteen gallons of water daily for seven days, from March 4 to 10 inclusive; a total application of one hundred and five gallons, equal to about half an inch of rainfall over the whole area beneath the tree top. Rains falling, as above described, added about fifteen gallons of water to this amount.

Forty per cent. of the young scales of the preceding year were alive on this tree when the treatment began. Three days after,

75 per cent. of these had been killed, and five days after, 84 per cent. The samples taken on the twelfth and nineteenth days showed an extraordinary percentage of living scales,—26 per cent. on each day,—and the average final ratio of scales killed stands at 79 per cent.

Tree No. 2.—A sixteen-foot tree, with a nine-inch trunk and an eighteen-foot top; in fair general condition, but badly infested with the scale. Treated with water but once, and that on March 4, the day succeeding the application of the insecticide spray. Rainfall of course followed on the 7th, 11th, and 15th, as on all other trees of this experiment, amounting to about fifteen gallons of water additional. Thirty-seven per cent. of the scales alive at the time of treatment; 78 per cent. of these dead three days after; and 86 per cent. dead on the twelfth day. The final general effect was the killing of 90 per cent. of the scales.

Tree No. 3.—An eighteen-foot tree, with an eight-inch trunk and a thirteen-foot top; in good general condition, but badly infested. Water treatment three days after the insecticide application, and twice on alternate days thereafter, making forty-five gallons of water thus applied. Twenty-nine per cent. of the scales alive when the treatment began; 53 per cent. of these dead on the third day and 79 per cent. on the seventh; the average final destruction of scales, 78 per cent.

Tree No. 5.—A fifteen-foot tree, with an eight-inch trunk and an eleven-foot top; in poor condition, badly infested. Sprayed with fifteen gallons of water five days after treatment, and again two days later. Forty-seven per cent. of the scales alive in the beginning; 80 per cent. of these killed by the sixth day, when the first count was made, and 90 per cent. by the twelfth; average final effect of the treatment, the destruction of 92 per cent. of the scales.

Tree No. 6.—A fifteen-foot tree, with an eight-inch trunk and a twelve-foot top; in poor condition, moderately infested by the San Jose scale. Treated but once with water, and this on the seventh day after the insecticide spray, when thirty gallons were applied. Sixty-four per cent. of the scales alive in the beginning; 84 per cent. of these dead by the sixth day and 86 per cent. by the twelfth; average ratio of scales finally killed, 86 per cent.

Tree No. 7.—An eighteen-foot tree with an eight-inch trunk and a ten-foot top; in poor general condition, moderately infested by the scale. Fifteen gallons of water on the thirteenth day after insecticide treatment, and another fifteen gallons on the fourteenth; before this, only the rainfalls already described. This tree and all the remaining trees of this lot were practically check trees

with regard to the effects of the water sprays, since these were applied after the full effect of the insecticide must have been produced. Sixty-eight per cent. of the scales alive in the beginning; 80 per cent. of these dead on the fifth day and 83 per cent. on the seventh; ratio finally killed, 88 per cent.

Tree No 8.--Seventeen feet high, with an eight-inch trunk and a twelve-foot top; in fair general condition, but badly infested with the scale. But one application of water, and that fifteen gallons on the fourteenth day after insecticide treatment. Fifty-four per cent. of scales alive in the beginning, and 54 per cent. of these dead on the third day; 90 per cent. dead on the sample representing the fifteenth day, with an average of 88 per cent. destroyed as the final effect of the insecticide.

Tree No. 9.—A sixteen-foot tree, with an eight-inch trunk and an eleven-foot top; in fair condition, but badly infested. No water (except rains) until the fourteenth day, when thirty gallons were applied. Fifty-six per cent. of the scales alive in the beginning; 83 per cent. of these dead on the fifth day and 87 per cent. on the twelfth; average final effect, 89 per cent. destroyed.

Tree No. 10.—A fifteen-foot tree, with a seven-inch trunk and a thirteen-foot top; in fair condition, moderately infested. No water was applied to this tree, and the effect of the insecticide was modified only by the natural rainfall already referred to. Sixty-nine per cent. of the scales alive in the beginning; 77 per cent of these dead on the third day and 95 per cent. on the sixth, with a final average result of 95 per cent. destroyed.

Taking the entire group of nine trees together, without reference to differences of treatment subsequent to the insecticide spray, it appears that an average of 52 per cent. of the scales were alive in the beginning; that 67 per cent. of these were dead by the third day, 82 per cent. by the fifth, and 86 per cent. by the sixth; and that the final average effect of the treatment was the destruction of 86 per cent.

Second Lot of Trees. California Wash.

Nine trees, partly apple and partly peach, sprayed with lime, sulphur, and salt on the 5th of March. Weather clear, with fairly strong northwest wind; temperature, 30° at 7 a. m. and 45° at noon. In this case the dead and living scales were counted on sample twigs and branches from a part of the trees just before the application of the insecticide, and from another part on the following day. The ratios of dead to living scales were practically identical in these two lots, thus showing, as has been already

LOT II. SPRAYED WITH LIME, SULPHUR, AND SALT, MARCH 5.

Tree	Scales	Mar. 5	Mar. 7	Mar. 9	Mar. 10	Mar. 15	Mar. 18	Mar. 20	Mar. 21	Mar. 22	Mar. 23	Mar. 24	Mar. 25	Mar. 12-25
4	No. counted ..	100	....	....	200	400	....	....	....	200	....	....	250	850
	Per ct. alive ..	42	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	....	83	87	....	....	....	80	....	....	68	78
20	No. counted ..	200	....	....	....	....	150	....	....	....	....	....	100	250
	Per ct. alive..	47	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	....	....	....	92	....	....	....	....	....	98	95
27	No. counted ..	200	....	150	300	....	....	250	....	....	....	....	200	450
	Per ct. alive ..	36	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	62	80	....	....	78	....	....	....	....	88	83
29	No. counted ..	200	....	200	....	200	....	200	....	....	200	....	150	750
	Per ct. alive ..	42	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	80	....	92	....	87	....	....	98	....	93	93
31	No. counted ..	300	....	200	100	....	....	250	....	....	....	....	200	450
	Per ct. alive ..	37	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	78	83	....	....	92	....	....	....	....	78	85
32	No. counted ..	300	....	300	....	300	....	....	200	....	200	....	300	1000
	Per ct. alive ..	44	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	69	....	86	....	....	79	....	89	....	87	85
33	No. counted ..	300	....	200	....	300	....	....	....	200	....	....	300	800
	Per ct. alive ..	45	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	....	70	....	80	....	....	.....	87	....	....	95	87
35	No. counted ..	200	200	....	200	....	300	....	300	....	....	200	300	1100
	Pet ct. alive ..	38	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	62	....	90	....	90	....	99	....	....	91	97	94
36	No. counted ..	200	300	....	200	....	200	....	....	....	....	200	200	600
	Per ct. alive ..	51	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	51	....	85	....	97	....	....	....	....	94	99	97
Totals	No. counted ..	2000	500	1050	1000	1200	650	700	500	400	400	400	2000	6250
	Per ct. alive ..	42	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed..	....	56	71	84	86	93	86	88	84	94	93	89	89

remarked, that scales killed the first day, if any, do not sufficiently change in appearance within that time to suggest the fact. Subsequent counts of scales were made for this lot on eleven later dates, the number counted, as before, ranging from one hundred to four hundred, and amounting for the lot to 10,500 specimens.

Tree No. 4.—An apple-tree, sixteen feet high, with a nine-inch trunk and a twelve-foot top; in fair condition, but badly infested by the scale. This tree received but one water treatment, and that on the 7th of March, two days after the insecticide application and on the same day as the first light fall of rain. Fifteen gallons

were applied, and approximately two gallons must be added for the rainfall. Scales alive in the beginning, 42 per cent. ; 83 per cent. of these killed on the sample for the fifth day, with an average of 78 per cent. as the final effect of the insecticide.

Tree No. 20.—A peach-tree, twelve feet high, with a six-inch trunk and a nine-foot spread of top ; in very poor condition, though but moderately infested by the scale. No water except the natural rainfall. Forty-seven per cent. of the scales were alive in the beginning ; 92 per cent. of these were dead on the thirteenth day, when the first subsequent count was made, and 98 per cent. on the sample for the twentieth day, the final average effect being reckoned at 95 per cent. destroyed.

Tree No. 27.—An apple-tree, fifteen feet high, with an eight-inch trunk and a seventeen-foot top ; in good condition, moderately infested with the scale. This tree was sprayed with water but once, and that five days after the insecticide application. Thirty-six per cent. of the scales were alive in the beginning; 62 per cent. of these were dead on the fourth day and 80 per cent. on the fifth, the average final effect being reckoned at 83 per cent. destroyed.

Tree No. 29.—An apple-tree, twelve feet high, with a seven-inch trunk and a fifteen-foot top ; in bad condition, and heavily infested. Twice treated with water, once on the fifth day after the insecticide spray and once on the tenth, in each case with fifteen gallons. Forty-two per cent. of the scales alive at the beginning of the experiment; 80 per cent. of these dead on the fourth day and 92 per cent. on the tenth day ; the average final effect, the destruction of 93 per cent. of the scales.

Tree No. 31.—An apple-tree, twelve feet high, with an eight-inch trunk and a nineteen-foot top; in good general condition, and moderately infested by the scale. Once treated with thirty gallons of water, on the next day after the application of the insecticide spray. Thirty-seven per cent. of the scales were alive in the beginning ; 78 per cent. of these were dead on the fourth day and 83 per cent. on the fifth; the final average effect of the insecticide, 85 per cent. destroyed.

Tree No. 32.—A peach-tree, twelve feet high, with a six-inch trunk and a nine-foot top ; in fair general condition, but heavily infested. Treated with fifteen gallons of water a day for three days in succession, beginning the next day after the insecticide spray was applied. The second of these treatments coincided with the first day's rain. Forty-four per cent. of living scales at the beginning ; 69 per cent. of these dead on the fourth day and 86 per

cent. on the tenth, according to the sample for that day ; the final average effect, the destruction of 85 per cent.

Tree No. 33 —A peach-tree, nine feet high, with a three-inch trunk and an eight-foot top ; in good condition, moderately infested by the scale. Sprayed twice in succession with fifteen gallons a day, following immediately upon the insecticide treatment, the second application coinciding with the first day's rain. Forty-five per cent. of the scales alive at the start; 70 per cent. of these dead on the fourth day and 80 per cent. on the tenth; final average effect, the destruction of 87 per cent. of the scales.

Tree No. 35.—A peach-tree, fifteen feet high, with five-inch trunk and a twelve-foot top; in poor condition, and moderately infested by the scale. Treated but once with water, and that on the tenth day after the experiment began, this treatment coinciding with the third day's rain. Thirty-eight per cent. of the scales alive at the time of the application of the insecticide; 62 per cent. of these dead on the second day and 90 per cent. on the fifth, with an average final destruction of 94 per cent. of the scales.

Tree No. 36.—A peach-tree, fifteen feet high, with a six-inch trunk and an eight-foot top; in poor condition, and heavily infested. Treated with water twice, once on the day following the insecticide treatment and once on the tenth day of the experiment, the last treatment coinciding with the third day of rain. Fifty-one per cent. of the scales alive in the beginning, and 51 per cent. of these dead on the second day after insecticide treatment; 85 per cent. dead on the fifth day, with a final average destruction of 97 per cent. of the scales.

Taking this group of nine trees as a whole and averaging all statements concerning them, it appears that 42 per cent. of the scales were alive when the experiment began; that 56 per cent. of these had been killed by the treatment by the second day thereafter, 71 per cent. by the fourth and 84 per cent. by the fifth; and that the final average effect was approximately 89 per cent. destroyed.

To this lot it will be convenient to add for discussion two other trees sprayed with lime, sulphur, and salt on the 7th of March, which, it will be remembered, was the day of the first rainfall occurring in the experimental period. These trees received no water treatment, but were intended as checks on the other experiments.

Tree No. 38.—The first of these was a peach-tree, nine feet high, with a five-inch trunk and a ten-foot top. It was in excellent condition, and only moderately infested. Thirty-eight per cent. of the scales were alive on the day preceding the insecticide

application, and on the day following the treatment 31 per cent. of these were dead. No other count was made upon this tree until the eleventh day, when 96 per cent. appeared to have been killed. The final general effect was an average of 89 per cent. of the scales destroyed.

Tree No. 39.—The second tree of this pair was also a peach-tree, about nine feet high, with a five-inch trunk and a ten-foot top. It was in excellent general condition, and moderately infested. Only 27 per cent. of the scales were alive when the experiment began; 29 per cent. of these were dead by the second day after treatment and 84 per cent. by the third day; and the general final effect averaged 91 per cent. of the scales destroyed.

General Results of Experiments with Lime, Sulphur, and Salt.

An analysis of the data contained in the above descriptions of Lots 1 and 2 and in the tables of percentages for those lots enables us to distinguish two groups of trees; those which received some treatment of water within five days after the insecticide application, and those which, if treated with water at all, did not receive it until the principal effect of the insecticide had already been produced. There are eleven trees in the first group, namely, 1, 2, 3, 4, 5, 27, 29, 31, 32, 33, and 36, and nine trees in the second, namely, 6, 7, 8, 9, 10, 20, 35, 38, and 39.

The average final effect of the insecticide upon the nine trees of the second group was the destruction of 90.6 per cent. of the scales, and the corresponding destruction on the eleven trees of the first group was 86.1 per cent., making a difference of 4.5 per cent. due to the action of water on the insecticide when applied within five days after the original treatment. In other words and more generally stated, it may be said that in these experiments the effect of thoroughly watering the treated tree during the first five days after the experiment began, was to diminish the destructive effect of the insecticide by approximately 5 per cent.

If, regardless of this difference, we take these twenty trees as a group, we find that 48 per cent. of the young scales of the preceding year were dead when the experiment began; and that 43 per cent. of these were killed by the second day after treatment, 60 per cent. by the third, 84 per cent. by the fifth, and 86 per cent. by the sixth. The average effect of the insecticide, as shown by counts made from the seventh to the twenty-second day, amounted to 88.4 per cent.; or, if we include only the counts from the tenth to the twenty-second day, it stands at 89 per cent.

LOT III. SPRAYED WITH LIME, SULPHUR, AND BLUE VITRIOL, MARCH 3.

Tree	Scales	Mar. 4	Mar. 6	Mar. 8	Mar. 9	Mar. 10	Mar. 15	Mar. 18	Mar. 20	Mar. 22	Mar. 23	Mar. 25	Mar. 10–25
11	No. counted	300	300	....	....	150	150	....	150	....	250	150	850
	Per ct. alive	67	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	85	....	....	93	93	....	92	....	88	98	93
12	No. counted	300	300	....	....	250	300	....	250	....	....	200	1000
	Per ct. alive	66	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	85	....	....	93	96	....	95	....	....	95	95
13	No. counted	200	....	....	....	250	250	350	....	....	300	300	1450
	Per ct. alive	57	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	....	....	89	94	95	....	....	96	98	94
14	No. counted	300	....	150	....	150	....	....	200	....	100	150	600
	Per ct. alive	49	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	83	....	96	....	....	93	....	84	96	92
15	No. counted	300	....	150	....	200	150	100	....	....	....	250	700
	Per ct. alive	61	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	87	....	80	81	97	....	....	....	98	89
16	No. counted	300	....	300	....	....	300	....	300	....	400	300	1300
	Per ct. alive	48	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	....	81	....	....	92	....	93	....	94	95	93
17	No. counted	300	200	....	150	....	300	....	150	....	....	150	600
	Per ct. alive	41	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	68	....	76	....	95	....	90	....	....	99	95
Totals	No. counted	2100	800	600	150	1000	1450	450	1050	....	1050	1500	6500
	Per ct. alive	56	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed	....	79	84	76	90	92	96	93	....	90	97	93

Third Lot of Trees. Oregon Wash.

This lot of experimental trees corresponds to the first in all particulars except that the Oregon wash of lime, sulphur, and blue vitriol was used as an insecticide instead of the California wash, and that the experiment was made with seven trees instead of nine. The variations in treatment omitted in this lot correspond to those of Nos. 5 and 7 of Lot 1. All were apple-trees, growing in the same orchard as those of the first lot.

Tree No. 11.—An eighteen-foot tree, with an eight-inch trunk and a twelve-foot spread; in excellent condition, and moderately infested. Sprayed with fifteen gallons of water daily for seven days, beginning March 4, the next day after insecticide treatment. Sixty-seven per cent. of the scales alive at the beginning of the experiment; 85 per cent. of these dead on the third day and 93 per

cent. on the seventh ; the average final effect of the insecticide, the destruction of 93 per cent. of the scales. Comparison with No. 1—similarly treated except that the California wash was used—shows a difference of 14 per cent. of the scales finally killed, in favor of the Oregon wash.

Tree No. 12.—A fifteen-foot tree, with an eight-inch trunk and a twelve-foot top; in fair condition, moderately infested with the scale. Sprayed but once, with fifteen gallons of water, on the day following the insecticide treatment. Sixty-six per cent. of the scales alive in the beginning; 85 per cent. of these dead by the third day ; 93 per cent. by the seventh, and 96 per cent. by the sample, on the twelfth ; the average final effect, the destruction of 95 per cent. Comparison with No. 2, the corresponding specimen of Lot 1, gives a difference in favor of the Oregon wash amounting to 5 per cent. of scales finally killed.

Tree No. 13.—A twelve-foot tree, with a six-inch trunk and a thirteen-foot top; in good condition, and but moderately infested. Sprayed with water three times, beginning March 6, with intervals of one day between applications, the first rainfall coming between the first and second sprayings. Fifty-seven per cent. of the scales alive in the beginning; 89 per cent. of these dead on the seventh day, when the first subsequent count was made, and 94 per cent. on the twelfth ; general average effect, the destruction of 94 per cent. On the companion tree, No. 3 of the first lot, an average final destruction of 78 per cent., making a difference of 16 per cent. in favor of the Oregon wash.

Tree No. 14.—This tree was thirteen feet high, with a six-inch trunk and a sixteen-foot top. It was in good condition but badly infested by the scale. It was treated but once with water, thirty gallons being applied seven days after the insecticide, agreeing in this respect with No. 6 of Lot 1. Forty-nine per cent. of the scales were alive in the beginning. Eighty-three per cent. of these had been killed by the fifth day, and, according to the sample count made, 96 per cent. by the seventh day. Owing, however, to a low ratio in the hundred-scales count on the twentieth day, the final effect stands at 92 per cent. of the scales destroyed. The corresponding ratio for No. 6 was 86 per cent.—a difference of 6 per cent., in this case, in favor of the Oregon wash.

Tree No. 15.—A thirteen-foot tree, with a six-inch trunk and an eighteen-foot top; in fair condition, but badly infested by the scale. This tree received no treatment with water until March 17, when 15 gallons were applied—fourteen days after the application of the insecticide. Tree No. 8 of Lot 1 is the companion tree.

Sixty-one per cent. of the scales on No. 15 were alive in the beginning; 87 per cent. of these were dead on the fifth day; and the final average stands at 89 per cent. This agrees practically with the average for No. 8, which was 88 per cent.

Tree No. 16.—A fifteen-foot tree, with an eight-inch trunk and a fifteen-foot top; in fair condition, but badly infested. This tree received no water treatment until the fourteenth day, when thirty gallons were applied. Forty-eight per cent. of the scales alive

LOT IV. SPRAYED WITH LIME, SULPHUR, AND BLUE VITRIOL, MARCH 5.

Tree	Scales	Mar. 5	Mar. 7	Mar. 9	Mar. 10	Mar. 15	Mar. 18	Mar. 20	Mar. 21	Mar. 22	Mar. 23	Mar. 24	Mar. 25	Mar. 12–25
	No. counted ..	300	200	....	300	400	....	300	....	....	200	....	200	1100
18	Per ct. alive ..	47	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	15	....	83	89	....	87	....	...	91	....	87	88
	No. counted ..	100	100	....	100	150	150	....	....	....	....	....	200	500
21	Per ct. alive ..	31	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	0	....	90	98	96	....	....	....	....	....	97	97
	No. counted ..	300	....	300	....	....	200	....	....	300	....	....	300	800
23	Per ct. alive ..	49	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	....	65	....	....	88	....	....	92	....	....	88	89
	No. counted ..	200	200	....	200	....	150	....	....	200	....	....	200	550
24	Per ct. alive ..	42	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	38	....	92	....	92	....	....	90	....	....	96	93
	No. counted ..	300	200	200	200	....	....	300	....	....	300	....	200	800
26	Per ct. alive ..	33	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	35	68	84	....	....	93	..	....	97	....	87	92
	No. counted ..	250	....	....	150	200	....	200	....	....	....	....	200	600
28	Per ct. alive ..	58	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	....	....	76	91	....	99	....	....	....	....	83	91
	No. counted ..	200	....	....	300	....	200	....	200	....	300	....	300	1000
30	Per ct. alive ..	44	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	....	....	92	....	86	....	83	....	93	....	92	89
	No. counted ..	300	....	....	300	....	300	....	200	....	150	....	200	850
22	Per ct. alive ..	44	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	....	....	88	....	90	....	98	....	94	....	98	95
Totals	No. counted ..	1950	700	500	1550	750	1000	800	400	500	950	....	1800	6200
	Per ct. alive ..	44	....	....	....	....	....	....	....	....	....	....	....	....
	Per ct. killed .	....	22	66	86	93	90	93	91	91	94	....	91	91

March 4; 81 per cent. of these dead on the fifth day and 92 per cent. on the twelfth, with a general final average of 93 per cent. destroyed. The corresponding tree of the other lot is No. 9, which shows a final average destruction of 89 per cent.

Tree No. 17.—An eighteen-foot tree, with a nine-inch trunk and an eighteen-foot top; in poor condition, and badly infested. A check tree, receiving no water treatment, the effect of the insecticide being consequently modified only by the three rains described. Forty-one per cent. of the scales alive in the beginning; 68 per cent. of these dead in three days and 95 per cent. in twelve, with a general average of 95 per cent. finally destroyed. This, it will be noticed, is the same final average result as that of the companion experimental tree, No. 10.

Fourth Lot of Trees. Oregon Wash.

This lot is essentially a duplicate of Lot 2 except with respect to the insecticide treatment, which was identical with that of Lot 3, and also with respect to the number of trees made use of, which was eight in this lot and nine in Lot 2. All variations of experiments with Lot 2 are represented in Lot 4 with the exception of that for No. 29.

Tree No. 18.—A sixteen-foot apple-tree, with a nine-inch trunk and a twenty-foot top; in fair general condition, but badly infested by the scale. Treated, like No. 4 of Lot 2, with a single application of fifteen gallons of water on the second day after the experiment, coinciding with the first shower of rain. Forty-seven per cent. of the scales alive when the insecticide was applied; 15 per cent. of these dead on the second day and 83 per cent. on the fifth, with a final average destruction of 88 per cent. The corresponding ratio for the companion tree, No. 4, was 80 per cent.

Tree No. 21.—A fifteen-foot peach-tree, with an eight-inch trunk and an eighteen-foot top; in good condition, and but moderately infested, This received the same water treatment as No. 27 of Lot 3, namely, one application of fifteen gallons of water on the fifth day after the insecticide. Thirty-one per cent. of the scales were alive in the beginning. None of them appeared to have been killed on the second day thereafter, but 90 per cent. of these were dead on the fifth day, and 98 per cent., according to the count made, five days thereafter. The general final average was 97 per cent. destroyed. The corresponding ratio for the companion tree, treated with the California wash, is 82 per cent.

Tree No. 22.—A peach-tree, thirteen-feet high, with a six-inch trunk and a twelve-foot spread; in poor condition, though but moderately infested. Treated but once, and that on the tenth day after the insecticide application, fifteen gallons of water being used. The corresponding tree of the second lot was No. 35. Forty-four per cent. of the scales alive in the beginning; 88 per

cent. of these dead on the fifth day, and 90 per cent. on the thirteenth, with a final average ratio of 95 per cent. destroyed; this to be compared with a 94 per cent. average of the companion tree.

Tree No. 23.—A fifteen-foot apple-tree, with an eight-inch trunk and a fifteen-foot top; in poor condition, moderately infested. This, like 32, treated with three daily water sprays of fifteen gallons each on three days immediately following the insecticide treatment—a duplicate in this respect of No. 32 of the second lot. Forty-nine per cent. of the scales alive in the beginning; 65 per cent. of these dead on the fourth day and 88 per cent. on the thirteenth, with a final average destruction of 89 per cent., that of the companion tree, treated with the California wash, being 85 per cent.

Tree No. 24.—A sixteen-foot peach-tree, with a six-inch trunk and a nine-foot top; in fair condition, moderately infested. Treated on two successive days immediately following the insecticide application with fifteen gallons of water on each day, the second of these treatments coinciding with the first day of rain. Forty-two per cent. of the scales alive in the beginning; 38 per cent. of these dead on the second day and 92 per cent. on the fifth, the average final result being the destruction of 93 per cent. of the scales—to be compared with 87 per cent. finally destroyed on the companion tree, No. 33, treated with the California wash.

Tree No. 26.—A twelve-foot peach-tree, with a six-inch trunk and an eleven-foot top; in very poor condition though but moderately infested. Treated, like No. 36 of the second lot, with fifteen gallons of water on the day following the insecticide application, and another fifteen gallons on the ninth day thereafter, that is, the 15th day of March. This last treatment coincided with the third rainfall. Thirty-three per cent. of the scales alive at first; 35 per cent. of these dead on the second day, 68 per cent. on the fourth, 84 per cent. on the fifth, and 93 per cent. on the fifteenth—when the next succeeding count was made. A general final average of 92 per cent. of the scales destroyed. The companion tree of the second lot gives a ratio of 97 per cent. finally killed.

Tree No. 28.—A fourteen-foot peach-tree, with a five-inch trunk and a ten-foot top; in very poor condition, though but moderately infested with the scale. This tree was reserved as a check upon the experiment, without water treatment of any kind, comparing in this respect with No. 20 of Lot 2. Fifty-eight per cent. of the scales were alive on it in the beginning; 76 per cent. of these were dead on the fifth day, and 91 per cent. on the tenth,

the final average destroyed being 91 per cent. The corresponding ratio for the companion tree of the previous lot was 95 per cent.

Tree No. 30.—A twelve-foot apple-tree, with an eight-inch trunk and a fourteen-foot top; in good condition, and but moderately infested. Treated but once, and that with thirty gallons of water on the next day after the application of the insecticide. Forty-four per cent. of the scales alive in the beginning; 92 per cent. of these found dead on the sample examined on the fifth day after treatment, the final average effect being the destruction of 89 per cent. of the scales. On tree No. 31, corresponding to this in the second lot, the average final ratio was 84 per cent. destroyed.

Comparison of Values of Oregon and California Washes.

Comparison of Lot 3 with the companion trees similarly treated in Lot 1 brings out very definitely the relative advantage of the Oregon wash. The general average of the ratios of final destruction is 93 per cent. for the Oregon wash and 87 per cent. for the lime, sulphur, and salt. If we limit the comparison to the three pairs of trees which received the water treatment within the first five days after the application of the insecticide, that is, to Nos. 1, 2, and 3 of Lot 1, and to 11, 12, and 13 of Lot 3, we find that in the latter 94 per cent. of the scales were finally killed, and in the former only 82 per cent.—an unmistakable indication that the Oregon wash was not at all affected in these experiments by water treatment; while the effect of the California wash was considerably reduced,—a clear difference of 12 per cent. of effectiveness in favor of the Oregon wash.

Comparing next the general averages of final effects shown by the ratios for corresponding trees of Lots 2 and 4, contrasting thus with respect to these two lots the advantages of the California and the Oregon wash, we find them to be as 88 per cent. and 92 per cent. respectively—a difference of 4 per cent. in final effect shown by this group of experiments in favor of the Oregon wash.

Bringing together the two lots representing each insecticide treatment and combining averages for the two insecticides as represented by the four lots of trees, it appears that 92 per cent. of the scales were destroyed by the *Oregon wash* on fifteen trees as compared with 87 per cent. on fifteen trees identically treated after spraying with the *California wash*—a difference of 5 per cent. in favor of the former treatment.*

*The slight difference between this statement and the one on p. 244 is due to the fact that in the former certain trees treated with the California wash were included which were not exactly duplicated as to treatment by any of those treated with the Oregon wash.

The Tent Experiment.

All the preceding experiments were intended to test the effect of artificial applications of water on the action of the two insecticides, these applications being made in a way to simulate the effects of rainfall. They were interfered with slightly by the three periods of light rain, the effects of which could not be clearly separated from those of the artificial treatment.

With a view to a test of the effects of rainfall, a small experiment was undertaken in which two trees—one treated with the California wash and the other with the Oregon wash—were covered with heavy canvas during the night and whenever rain threatened by day. Two other trees were similarly treated and left at all times exposed, and still two more, selected because of their close correspondence to the experimental trees, were reserved without treatment, as checks. This experiment was begun March 20. The trees selected (the only ones remaining available) were peach-trees on high ground and light soil, heavily infested, and in very poor condition. The drouth of the preceding season had affected them very seriously, the young wood being largely killed, and only 29 per cent. of the young scales on them being still alive.

The weather was favorable to the experiment. The insecticides were applied on the afternoon of March 20, and a slow fine rain began at 5 p. m. of the same day and continued until nine o'clock and for an unknown time into the night, Rain fell in a continuous drizzle, broken by showers, the whole of the following day, March 21, to an amount estimated by Mr. Titus at more than thirty gallons per tree.

The temperature of the 20th was 34° at 7 a. m. and 57° at noon; that of the 21st was 44° at 7 a. m. and 52° at noon, the wind from the southeast both days. Observations on this experiment continued only until the 25th, but counts of the scales were made daily up to that time—3,000 scales for the four experimental trees, and 2,050 for the two checks.

In this small experiment no differences of any significance were made out in the action of the insecticides, the total general effect being the destruction of approximately 95 per cent. of the scales, and variations from this average in the individual trees being too slight to take into account. So far as any conclusion can be drawn from an experiment on so small a scale, we can only infer that a rainfall such as described, occurring at the time of the insecticide treatment, would have no appreciable effect on the action of either of the washes. The apparent extraordinary efficiency of the

washes on these trees is plausibly explained by Mr. Titus as connected with the poor condition of the trees and the probable consequent low vitality of such of the scale insects as remained alive.

Effects of Rain and Water Sprays in Washing off Dead Scales.

Noticing that many scales were loosened and washed away after insecticide treatment of the trees, Mr. Titus made some careful counts from day to day of selected lots of scales on the experimental trees to determine the circumstances and the ratio of their diminution in numbers. Selecting, for example, a definite part of a branch, counting a hundred scales on it when the insecticide was applied and marking the area occupied by them, he counted them each day thereafter for several days and thus arrived at an exact conclusion as to the effect of the fluid applications and the incidental rains. Thus, on No. 1, 300 scales counted March 3 were reduced to 188 by March 15—a loss of 37 per cent. On No. 11, 400 scales were reduced in the same time to 223—a loss of 22 per cent. Both these trees, it will be remembered, were sprayed with the insecticide March 3, and daily thereafter for one week with fifteen gallons of water. On No. 3, 100 scales were reduced in eight days to 72—a loss of 28 per cent., this tree having been three times sprayed, with fifteen gallons of water each time. On No. 6, sprayed once with thirty gallons, the loss was 25 per cent. in eight days; and on No. 14, receiving the same treatment except that the insecticide used was the Oregon instead of the California wash, the loss for the same period was 11 per cent. No. 21, sprayed also but once, with 15 gallons of water, lost 20 per cent. of its scales in seven days; No. 42, exposed to rains for a day and a night, lost in five days 11 per cent. of its scales; and No. 43, similarly exposed, lost 15 per cent.

The check trees 40 and 41, on the other hand, kept without treatment of any kind, lost within five days but four scales out of five hundred counted.

It was further apparent from observations made in the field that a brief but hard and dashing rain would detach many more scales than a light rain longer continued and that a fine misty rain did not loosen the scales at all.

PRACTICAL CONCLUSIONS.

The foregoing described observations and experiments go to show that the Oregon wash of lime, sulphur, and blue vitriol, prepared as described on p. 246, is a valuable insecticide for winter

use in the climate of Illinois for the destruction of the San Jose scale; that its full effect will be produced in about a week; and that frequent short rains will not noticeably diminish or delay its action, even when they come within the first five days after the insecticide treatment. It is entirely harmless to any leafless tree, and hence may be freely used in winter (but in winter only) for all kinds of trees, shrubs, and vines.

The California wash of lime, sulphur, and salt, prepared as described on p. 246, is a little less effective than the Oregon wash as a scale destroyer, and is considerably more likely to deteriorate after application if exposed to rains within the first few days. Otherwise its effects and characteristics are very similar to those of the Oregon wash,

It should be generally known that both these washes corrode brass and copper rapidly, and that consequently an iron pump may be used to better advantage in spraying them than one made in part of brass.

With respect to the comparative effectiveness of these washes and the better known whale-oil soap and coal-oil mixtures we have as yet no accurate knowledge. There is nothing to indicate, however, that the former are less effective here than on the Pacific Coast, where they seem to have been found very satisfactory in the hands of the ordinary orchardist for the destruction of the San Jose scale. Over both the latter applications they have the very great advantage that they are harmless to the tree, and that they do not endanger the crop of the following year. They are also decidedly cheaper than either the whale-oil soap or the kerosene emulsion. In our winter's work the cost of the materials for these various mixtures has been $1.12 per hundred gallons of the Oregon and the California washes; $2.80 per hundred gallons of kerosene emulsion, diluted to contain twenty per cent. of kerosene; and $6.50 for the same quantity of the whale-oil soap solution, at the usual strength of two pounds to the gallon of water.